Temperature and Dissolved Oxygen Transects For Nantucket Harbor 2001

Prepared for the Town of Nantucket

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Temperature and dissolved oxygen transects were conducted in Nantucket Harbor for the year 2001 in order to approximate warming and cooling trends related to scallop reproduction and development. Spawning and feeding are temperature dependent physiological processes of the scallop. Dissolved oxygen is also an important factor in determining the location of scallop populations; based on the level of oxygen content they need in the water in order to survive in certain areas. By monitoring these two factors throughout the harbor it is possible to determine when and where scallops have spawned, when they will begin to feed, i.e. mature, and when they will fall into a period of cessation i.e. stop growing. This data there fore will give us a better understanding of the scallop's life cycle.

Five transects were established across the harbor running north to south in each basin, with several sampling points along each line (Map #1). These transects and points were picked to provide information about bottom characteristics throughout the harbor. They include shallow (4'), mid (12'), and deep water (22') bottom points; and also depth ranges in between. These points were sampled from the Harbormaster's boat using a Garmin GPS positioning system, and a Raytheon depth finder while referencing (Map #1). A YSI 85 meter with a 30' cord and weighted probe was used to record temperature and dissolved oxygen at bottom depths at these points. Seventeen sampling events were conducted in '01 from January to November '01, also included was data taken from a harbor sampling in February '02. Transects were not done in December '01 and January '02 due to conflicts with wardening the scallop fishery.

The information gathered was compiled, calculated and translated on to eight graphs (1.1, 1.3, 1.5, 3.1, 3.4, 5.2, 5.3, and 5.4). These points represent transects 1,3, and 5, and are believed to be sufficient because the harbor is for the most part isothermic. This means that there is good mixing of temperature throughout the water column. There are also subtle variations, which can be determined from these three tansects that enable us to determine approximately when spawning events took place in different parts of the harbor. Hypoxic and anoxic levels can also be approximated at specific times and locations, as well as feeding periods and lengths of cessation.

Analysis of this data and interpretation of these graphs show some general trends and a few detailed events throughout the year. Though there is very little stratification there are differences between shallow, mid, and deep-water areas. In general mid and deep-water areas tend to be colder with lower dissolved oxygen levels. Another general trend involves the circulation of the harbor; where by the water in the head of the harbor (Wauwinet) is exchanged at a slower rate than that at the opening (Channel). This was shown in the Nantucket Harbor Circulation Computer Model provided by ASA (Applied Science Associates). The transects show that because of this type of circulation the head of the harbor warms up faster in the summer, and cools down faster in the winter than Nantucket Sound, and mid harbor areas.

Specific details of this analysis show that spawning occurred in early June between the 6/4 and 6/25 sampling dates. Temperatures in shallow depths (4') of water first peaked through the 20 degree Celsius mark at the head of the harbor, graph (1.1). This spring set was soon followed by a spawning in the mid harbor areas, graph (3.1). Last to spawn were the scallops in and around the foot of the harbor during mid June; this area covered roughly the Horse Shed, Hussey Shoal, Monomoy Piers, and The Mooring Field, graph (5.4). This analysis is congruent with Belding's findings that mature

scallops are induced to spawn by temperatures rapidly rising or falling between 17 and 22 degrees Celsius. Graphs (1.1, 1.3, and 3.1) depict a temperature change in mid July around the 7/12 sampling date that could have resulted in a mid summer spawning event of mature scallops that had not spawned in the spring event due to their age. The fall set is believed to have occurred around the 9/21 sampling event as shown on all graphs where temperatures began to fall throughout the harbor and in the Sound with the onset of winter.

When temperatures rise above 7 degrees Celsius metabolic processes like feeding begin within the scallop (Belding). The graphs show that these temperatures had been attained by mid March, from the 3/19, and 4/11 sampling events. Temperatures did not fall below 7 degrees Celsius until after the 11/8 sampling event. It is believed that water temperature did not decrease until mid December, which would have resulted in a seven-month feeding period. Conversely it may be estimated that for five months there would have been a period of cessation, assuming that warming and cooling trends last approximately the same amount of time each year. This period of cessation in the scallop's metabolic processes results in a well defined raised annual growth line on the scallop's shell and is used as the determining factor in the judgment between juveniles and adults (Belding).

Trends observed were that the head of the harbor warms and cools faster than the rest of the harbor as a result of water being trapped there for longer periods of time. Also temperature is inversely proportional to depth and dissolved oxygen, and results in hypoxia and anoxia in certain parts of the harbor at certain times of the year. There were two distinct changes in temperature in the harbor, which would have resulted in two definite spawning events, whose dates can be closely approximated. Cold water temperatures in the harbor would have resulted in five months of cessation for the scallop population, with a growth and feeding period of seven months. The temperature changes also help to determine how old scallops would be, based upon when they were spawned, and their level of sexual maturity. Age is shown by the location of the growth ring, or rings on the shell and the coloration of the gonad after the last spawning event. Transects will be conducted in 2002 on a smaller scale in order to note continuing trends or yearly changes.